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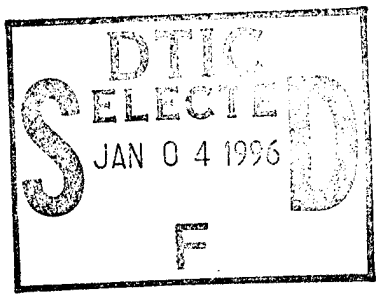

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STRESS REACTIVITY AND ATTRITION IN TWO BASIC TRAINING POPULATIONS[†]

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Summary

Problem

Personality variables are established correlates of attrition from basic training, but the best method of using information from personality scales for predicting attrition is uncertain.

Objective

A previous study of recruits who experienced significant medical problems during basic training showed that a simple typology which classifies recruits as stress reactive (R+), stress neutral (N), or stress resistant (R-) predicted attrition better than the common approach of assessing personality in terms of graded differences on continuous dimensions. The present study attempted to replicate these findings in the general U.S. Navy recruit population and to determine whether the stress reactivity model applied to the U.S. Marine Corps recruit population.

Approach

Standardized personality questionnaires were administered to U.S. Navy (n = 1,546) and U.S. Marine Corps (n = 2,079) recruits at the beginning of training. These questionnaires were scored for the stress reactivity typology, for two alternative typologies with four and five groups, respectively, and for five general dimensions of personality. Multivariate analyses of variance and loglinear analyses determined the relationships between these personality models and attrition status as determined from training records.

Results

R+ individuals showed significantly higher than average attrition and R- individuals showed significantly lower than average attrition in both populations. A single predictive model of the reactivity-attrition relationship fit the data for both populations. The three-group typology was as effective as the dimensional model in predicting attrition, but a fourth type characterized primarily by low agreeableness also showed above average attrition in both samples.

Conclusions

Stress reactivity is associated with attrition from basic training in both the Navy and Marine Corps recruit populations. The reactivity typology might be improved by adding a fourth group, but additional study is needed to verify that this trend was not the result of imprecision in the current stress reactivity classification procedure. Even with a fourth type added, the typological approach provides a relatively simple basis for identifying recruits at high risk for attrition.

Introduction

Stress reactivity is a personality typology that may predict reactions to military basic training and other stressful situations. The initial impetus for research on this construct came from studies of behavioral and biological reactions observed in children (Kagan, 1989; Kagan, Reznick, & Snidman, 1986) and nonhuman primates (Higley & Suomi, 1989; Sapolsky, 1990a, 1990b). The present study examines the relationships between a provisional stress reactivity typology developed by Vickers (1991) and attrition from basic training as one possible stress effect. The study was undertaken to test the generalizability of a previous finding that stress reactive individuals had above average rates of attrition while stress resistant individuals had below average rates of attrition in recruits who experienced medical problems during basic training (Vickers, Hervig, & Bischoff, 1991). Generalizability tests were provided by extending the work to the general male recruit populations of the U.S. Navy and the U.S. Marine Corps.

Stress Reactivity Typology

Vickers (1991) used cluster analyses of scores from a standardized personality inventory (Costa & McCrae, 1985) to develop a provisional classification procedure for identification of stress reactive and stress resistant types in young adult male humans. The procedures included replication of cluster structures over 10 subgroups of a large sample of U.S. Navy recruits. Two replicable groups had personality profiles that approximated a priori characterizations of stress reactive (hereafter, R+) and stress resistant (hereafter, R-) individuals derived from prior observational data reported in the child and primate research on reactivity. R- individuals were conscientious and emotionally stable with weaker tendencies to be extraverted, agreeable, and open to new experiences. R+ individuals showed the mirror image of the R- personality profile, except that they were average with respect to openness to experience.

The typical treatment of stress reactivity in studies of children and primates combines all individuals who are neither reactive nor resistant into a single intermediate group (hereafter, "stress neutral" or "N"). However, the cluster analyses suggested that this intermediate group might include as many as three reliably distinct subgroups (Vickers, 1991). A provisional typology with five groups was adopted to determine whether there were behavioral differences

among the stress neutral subgroups which would falsify the stress reactivity model. The intermediate groups were characterized primarily by moderate elevations on one or two scales and are referred to hereafter as "low agreeableness" (A-), "high agreeableness" (A+), and "high conscientiousness" (C+).

Previous Attrition Findings

The first validation study undertaken for the provisional stress reactivity typology compared the five groups with regard to attrition from basic training following the development of a significant, but treatable, medical problem during basic training (Vickers et al., 1991). The medical rehabilitation setting was chosen for the initial study because medical problems were believed to represent an additional challenge superimposed on the common stresses of basic training. This challenge was expected to accentuate differences between R+ and R- individuals assuming that stress is required for the effects of these personality differences to be manifest (Tellegen, 1991). The inference that medical rehabilitation involved a higher stress level than training which was not interrupted was based on anecdotal descriptions and evidence of much higher than average attrition in this population for nonmedical reasons (Hervig, Vickers, & Bischoff, 1991).

The special problems encountered by the recruits in the initial study made it uncertain whether the initial findings would generalize to recruits who had relatively routine basic training experiences. It was reasonable to expect that the results would generalize if stress is the key factor in the previously observed associations. This expectation was based on descriptions of basic training which consistently emphasize the need to meet a number of adaptive challenges (Bourne, 1967; Janis, 1945; Maskin & Altman, 1943; Zurcher, 1968). The period of maximum challenge is associated with relatively strong negative emotions on the average (Datel & Engle, 1966; Datel, Engle, & Barba, 1966; Datel, Gieseking, Engle, & Dougher, 1966; Datel & Lifrak, 1969; LaRocco, Ryman, & Biersner, 1977), so the typical recruit experiences heightened psychological distress during this time. Individual differences in distress at this time are related to cortisol excretion (Rose, Poe, & Mason, 1968) and secretion (Vickers, Hervig, Wallick, Poland, & Rubin, 1987), so psychological and biological stress indicators converge at this time. However, the Vickers et al. (1991) findings may have been contingent on the exceptional stresses encountered by the recruits with medical problems, so examination of the same relationships in

the general recruit population provided a constructive extension of the earlier work.

Tests for differences in stress reactions will yield valid conclusions only if the behavioral measures employed are reasonable indices of reactions to stress. Attrition from basic training was chosen as the initial behavioral index of reactions to training stresses because there is evidence that stress influences attrition. Prior research indicates that most attrition occurs during the early phases of training when stress is highest and that individuals who possess personality characteristics that should sensitize them to stress are more likely to attrite than others (cf., Vickers et al., 1991). However, it should be kept in mind that stress is only one influence on attrition. Other influences include the judgments of training personnel about a recruit's probable performance after basic training, personnel qualification guidelines set by the organization (e.g., past legal problems, health problems), or problems arising during training which do not derive from the problem of adapting to training challenges (e.g., previously unidentified health problems, failure of the service to provide anticipated career opportunities). Thus, attrition probably is influenced by stress, but it is not a pure stress response indicator.

Three results from the Vickers et al. (1991) study were particularly important for the present extension. First, comparisons of the three subgroups in the stress neutral category in the stress reactivity model showed no significant differences in attrition rate. Second, the attrition rate was higher than average among R+ recruits and lower than average among R- recruits. Third, the stress reactivity typology was slightly more effective than a linear discriminant function for predicting attrition from basic training. The significance of this last point lies in the fact that the typology predicted better than the optimum linear combination of raw personality scores possible derived using the sample data. The superiority of the typological prediction is remarkable because the procedures for determining typological status were specified without reference to information about attrition status. This a priori prediction contrasted with the post hoc use of knowledge of attrition status when developing the predictive equation based on personality dimensions.

Present Study

As indicated above, the present study was undertaken to replicate and extend the initial validation research for stress reactivity. The extension tested the generalizability of the initial findings along two dimensions which may have influenced the findings from the initial study.

The first aspect of generalizability was to determine whether similar results occur for recruits in the general recruit population. Vickers et al. (1991) intentionally chose a population which could be judged to face exceptional stress based on the presence of extremely high attrition rates relative to the recruit population at large (Hervig et al., 1991). While this choice was appropriate for the initial study, it left open the question of whether stress reactivity also would predict attrition under less stressful circumstances.

Current models of personality emphasize the importance of the situation in eliciting the individual differences which define a personality profile (e.g., Tellegen, 1991). The presumably less stressful conditions facing the general recruit population therefore might result in less activation of the personality complexes represented by different types. If so, the differences between R+ and R- individuals would be expected to be less pronounced than in the earlier study. In the extreme case, the differences might disappear all together.

The situational activation view of personality also presents the possibility that the findings for the subgroups in the N category would not generalize from the medical rehabilitation population to the general recruit population. It may be that the specific challenges of medical rehabilitation did not provide the types of stimuli that would lead to attrition differences in the N subgroups. Conceivably, a wider range of stimuli are encountered in the typical training environment, so subgroup differences might occur there.

The second aspect of generalizability explored in the present study was whether Navy basic training results also applied to U.S. Marine Corps basic training. While these basic training settings share many elements common to all military basic training programs, observations suggest that they differ with regard to several elements, including relative emphases on academic versus physical training and style of supervision. These differences may differentially activate personality characteristics in ways that alter the relationship between reactivity and attrition.

General Hypotheses

Well-established relationships between personality and job performance (Barrick & Mount, 1991; Kamp & Hough, 1988) combined with the personality profiles of the stress reactivity groups make it reasonable to expect that the previous findings would generalize to the overall Navy and Marine Corps recruit populations. Given that this prediction is trivial, two more detailed issues are the focal points for this report. First, the stress reactivity model would predict

that only three types must be distinguished to represent the relationships between personality and stress responses. This claim would be questionable if the N subgroups in the provisional typology differ significantly on stress-relevant criteria. Thus, one focal point for the present study was an attempt to replicate Vickers et al.'s (1991) finding that the three intermediate groups identified in the provisional stress reactivity typology did not differ with respect to attrition rate.

The second focal point was the stress reactivity claim that a categorical model is appropriate for conceptualizing individual differences in sensitivity to stress. This claim was tested by comparing the typological model with the common practice of treating personality constructs as continuous dimensions. While the two approaches are not necessarily incompatible (Meehl, 1992), evidence that dimensional predictions of attrition were more precise than those provided by the typological model would weigh against the stress reactivity model.

Combining the preceding considerations, the major hypotheses in the present study were:

(a) Reactive recruits will have higher than average attrition rates, resistant recruits will have lower than average attrition rates, and recruits in the intermediate groups defined by Vickers (1991) would have average attrition rates.

(b) The relationship between reactivity status and attrition will be equal in the two recruit populations.

(c) Scores on personality dimensions will not be related to attrition status after controlling for reactivity status.

Methods

Samples

The Navy recruit sample consisted of 1,546 males who volunteered to participate in studies of risk factors for infectious diseases in basic training. The modal age in the sample was 18 years with 72% of the participants between 17 and 19 years of age; overall, ages ranged as high as 33 (mean = 19.4 years, SD = 2.7 years). The majority (73%) of these recruits had 12 years education, but a substantial minority (20%) had more than 12 years of education while a smaller number (7%) had between 9 and 11 years of education. The ethnic composition of the sample was predominantly Caucasian (71%), with Blacks (15%) and Hispanics (7%) the largest minorities. Other minority groups accounted for the remaining 7% of the sample.

The Marine Corps recruit sample consisted of 2,079 males who volunteered to participate in a study of the effects of psychological stress in basic training. The modal age in the sample was 18 with 75% of the participants between 17 and 19 years of age; ages ranged as high as 30 (mean = 18.9 years, SD = 1.9 years). The majority (61%) of these recruits had 12 years education, but a substantial minority (28%) had between 9 and 11 years of education while a smaller number (11%) had more than 12 years of education. The ethnic composition of the sample was predominantly Caucasian (72%), with Blacks (15%) and Hispanics (8%) the largest minorities. Other smaller minority groups accounted for the remaining 5% of the sample.

Personality Measures

The NEO Personality Inventory (NEO-PI; Costa & McCrae, 1985) was administered to the U.S. Navy recruit participants. This inventory consisted of 180 items which were answered with a five-point Likert scale format with options ranging from "Strongly Disagree" through "Neither Agree nor Diasgree" to "Strongly Agree." The inventory items represent five major domains of personality, including:

(a) Neuroticism (N) assesses adjustment versus emotional instability. Specific facets of neuroticism include anxiety, hostility, depression, self-consciousness, impulsiveness, and vulnerability to stress.

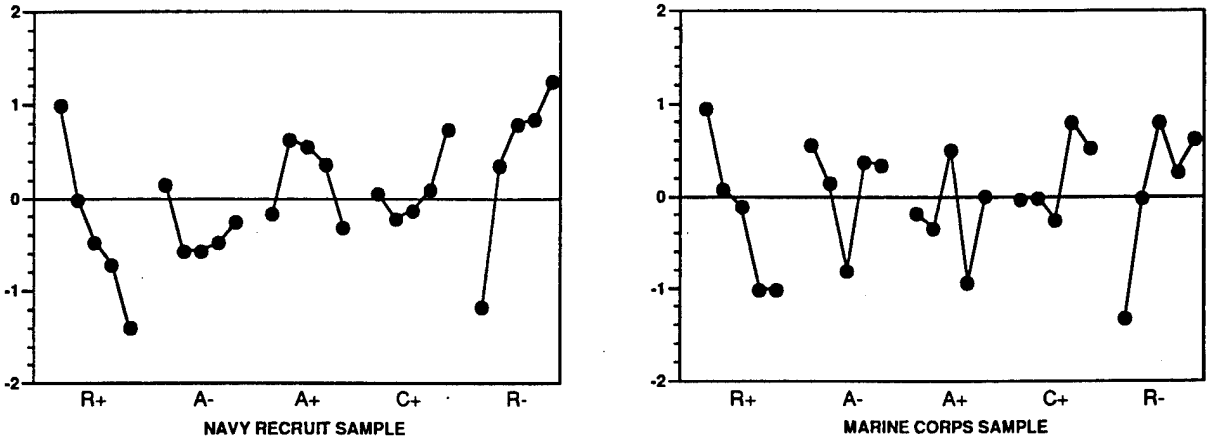
(b) Extraversion (E) assesses qualities of interpersonal interactions combined with typical activity levels, excitement seeking, and capacity for positive emotions. Specific facets include interpersonal warmth, gregariousness, assertiveness, typical activity level, excitement-seeking propensity, and frequency and intensity of positive emotions.

(c) Openness to experience (O) assesses the person's tendency to seek and become deeply involved in new experiences and to try to fully appreciate and be aware of one's feelings and surroundings. Specific facets of openness include frequency of daydreaming and fantasy, value placed on aesthetics, sensitivity to one's feelings, preference for novel activities, intellectual curiosity, and tolerance of a range of ideas.

(d) Agreeableness (A) assesses interpersonal orientation in terms of tolerance versus antagonism or trust versus cynicism.

(e) Conscientiousness (C) assesses organized, persistent pursuit of goals in contrast to unreliability, sloppy work and undependability.

More detailed definitions of A and C have been developed in recent years, including specific facet scales for these two domains (Costa, McCrae, & Dye, 1991). The earlier, less refined definitions have been paraphrased here to indicate the conceptualization of these variables which guided the development of the measures actually employed in this study. These measures are highly correlated with the revised measures incorporating conceptual and measurement refinements, so the interested reader may refer to more recent works (Costa & McCrae, 1992; Costa et al., 1991) for greater detail.



Note. Profiles give the standardized means in the following order: neuroticism, openness, agreeableness, extraversion, and conscientiousness. Group means were standardized using the pooled within group SD for the sample.

FIGURE 1. COMPARISON OF PERSONALITY TYPES ACROSS TWO SAMPLES

The NEO-PI was scored for the five major personality dimensions with 48 items each for neuroticism, extraversion, and openness to experience, and 18 items each for agreeableness and conscientiousness. The internal consistencies of the scales were comparable to those reported by Costa and McCrae (1985).

Typological status was based on the cluster analyses of NEO-PI scores for 3,028 male U.S. Navy recruits described by Vickers (1991). In fact, the present sample was a subset of the

individuals who provided data for earlier analyses and for whom attrition status was known. Personality profiles for the five reliable clusters reported by Vickers (1991) are shown in Figure 1.

A subset of true-false items from the California Psychological Inventory (CPI) provided the measure of personality for the Marine Corps recruits. The items originally assessed a set of coping and defense mechanism measures (Joffe & Naditch, 1977) because these data originally were collected to test hypotheses about stress, coping, and defense in Marine Corps basic training (Vickers & Conway, 1983). The present application was made possible by sorting the items into groups based on the item content, then determining for each group of items which dimension it represented. The resulting five measures provided somewhat different operationalizations of the five-factor domain than the corresponding NEO-PI measures:

(a) Neuroticism assessed aspects of anxiety, pessimism, guilt, irritability and hostility, low self-esteem, and ease with which one could be upset or distracted.

(b) Extraversion assessed tendencies to be sociable, exhibitionistic, dominant and a leader. In addition, this dimension included indicators of general energy level, optimism, and liking for excitement.

(c) Conscientiousness assessed differences in tendencies to be responsible, persevering, and dependable combined with the tendency to set high standards and strive for success.

(d) Agreeableness assessed differences in the extent to which individuals had positive views of other people and were willing to adapt their behavior to improve social relationships as indicated by being cooperative, pleasant, tactful, modest, and so on.

(e) Openness assessed primarily differences in the pursuit of cultural interests and curiosity with additional components related to holding liberal, possibly unconventional views, and being tolerant of ambiguity.

Scores on these scales were cluster analyzed following the procedures described by Vickers (1991). The results indicated that a five-cluster solution was one reasonable solution (Appendix A), and comparison of the personality profiles for the groups provided reasonable matches to the resistant and reactive types in the Navy recruit population (Figure 1). The matches for the intermediate groups were weaker than those for the extreme reactivity types, but some similarities existed which were used to label these groups. One group was designated "A-" on the grounds that the most consistent deviation from the population mean was a lower than

average score on agreeableness. For similar reasons, the two other groups were designated "A+" and "C+" based on above average scores for agreeableness and conscientiousness, respectively.

Attrition Criterion

The attrition status of the recruits was determined from records maintained at the Recruit Training Command, San Diego, or at Marine Corps Recruit Depot, San Diego, as appropriate. Reasons for attrition were reviewed and classified into those which indicated difficulty adjusting to demands of training and other types of attrition. In the following pages, the first type of attrition will be referred to as "adaptive attrition" to emphasize its presumed dependence on stress processes occurring in training. The second type of attrition will be referred to as "other attrition" to emphasize that this measure includes a number of different types of attrition which are assumed not to depend on stresses actually occurring in basic training.

In the case of Navy recruits, the major organizational reasons for attrition classified as adaptive attrition were unsuitability indicated by a situational reaction, administrative discharge for nonadaptability to military life, and unsuitability because of lack of motivation. In the case of Marine Corps recruits, the primary specific reason for this type of attrition was unsuitability because of apathy, defective attitude, or inability to expend effort constructively. These types of attrition depended on behaviors that actually occurred in basic training and, therefore, presumably could be precipitated by any psychological stresses occurring in this setting.

In both samples, the reasons for attrition causing a recruit to be classified in the "other attrition" category were most likely to be attrition based on events which occurred prior to entering training or on medical problems. The reasoning was that attrition arising from these latter two sources was not an indication of failure to cope with the specific stressful elements of basic training. Indeed, individuals falling in this category could be adapting successfully to the psychological demands of training at the time of discharge, but be forced to leave because of administrative guidelines or health problems. It should be noted, however, that individuals in this second category, of course, also may have had problems adapting to training even though they were discharged for other reasons. This argument could apply with particular strength to administrative attrition based on behavioral problems which arose from stress-related problems occurring prior to entry into the military. Despite this ambiguity, the distinction between stress attrition and other attrition was introduced in the hope that the former category might provide a

less contaminated measure of severe behavioral responses to stress than would result from lumping together all types of attrition. If so, adaptive attrition will provide a better criterion for the present purposes and should be more strongly related to stress reactivity than will be the case for other attrition.

Analysis Procedures

Loglinear analyses were performed to assess the relationships between the reactivity typology and attrition status. The loglinear analyses were conducted by applying the BMDP 4F (BMDP Statistical Software, Inc., 1990) program in two stages. The first stage analyzed a crosstabulation of attrition status by typological status for the three intermediate groups of the provisional stress reactivity typology. This element of the analyses tested the hypothesis that these groups did not differ with respect to attrition. The second stage of the loglinear analyses compared the reactive and resistant groups with the intermediate groups. Additional loglinear analyses were conducted as follow-ups to these planned analyses for reasons described in the presentation of results.

Two-way multivariate analyses of covariance tested the hypothesis that personality would not be related to attrition status controlling for typological differences. These analyses employed typological status and attrition as group classification variables and the five personality dimension measures as the dependent variables using the SPSS-X MANOVA program (SPSS, Inc., 1988) with hierarchical decomposition of variance for the computations. Typological status was entered as the first group classification variable to consider, so the relationship between attrition status and personality was determined controlling for typological status.

The preceding analyses were conducted separately in each sample to permit direct replication of prior trends in two different populations if possible. In each case, the results of the within-population analyses were compared to determine which findings replicated across populations. Formal comparisons of two types were made:

(a) Hypotheses regarding specific parameters in a given analysis were evaluated by testing for the pooled significance of that parameter using procedures outlined by Rosenthal (1978).

(b) Cross-validation of models was assessed by applying the parameter values estimated in one sample to the data from the other sample. The results of these cross-validations are reported in terms of a fit index which was defined as

Fit Index = 1 - (Model chi-square/Null chi-square)

where "model chi-square" was the overall cross-validation chi-square and the "null chi-square" was the chi-square obtained assuming that each cell frequency was equal to the expected frequency if attrition and typological status were uncorrelated. The cross-validation chi-square was the sum of the chi-squares for individual cells computed by taking the difference between the observed cell frequency and the expected cell frequency computed on the basis of the model which was being cross-validated, squaring the difference, then dividing by the expected value used in computing the difference.

Results

Reactivity Status and Attrition

Attrition Differences Among Neutral Groups. Attrition patterns were comparable for all three stress neutral groups in the Navy data (chi-square = 4.42, 4 df, $p < .335$) and in the Marine Corps data (chi-square = 6.25, 4 df, $p < .164$). Overall, the cross-validation procedures showed that fitting the parameter values from one population to the data from the other actually produced poorer fit to the data than was provided by the null model which was based on the assumption of no association between reactivity status and attrition (Navy cross-validation chi-square = 7.04; Marine Corps cross-validation chi-square = 11.41).

Diffuse significance tests (i.e., tests involving more than one degree of freedom or one parameter, cf., Rosenthal & Rosnow, 1984) can conceal specific aspects of data which should yield a rejection of the null hypothesis. In the present case, the chi-square tests described above were diffuse in the sense that they involved four degrees of freedom. Examination of individual parameters indicated a consistent tendency for the A- group to have lower graduation rates (Navy loglinear parameter = -.164, multiplicative parameter = .849; ratio = -2.14; Marine Corps loglinear parameter = -.216, multiplicative parameter = .806; ratio = -1.65; pooled $z = -2.67$, $p < .004$, one-tailed) as a result of higher adaptation attrition (Navy loglinear parameter = .226, multiplicative parameter = 1.254, ratio = 1.95; Marine Corps loglinear parameter = .392, multiplicative parameter = 1.48, ratio = 1.71; pooled $z = 2.40$, $p < .009$, one-tailed). All other parameters again were modest relative to their associated standard errors (absolute value = 1.21

or less) and none produced significant pooled results (pooled $z < 1.34$).

Attrition Differences Among Reactivity Groups. Initial loglinear analyses of reactivity and attrition contrasted attrition rates for stress reactive recruits and stress resistant recruits with all other recruits combined and classified as neutral. This typological classification was based on theory and the preceding evidence that the three neutral groups did not differ reliably in the overall chi-square analysis for both samples. These analyses showed significant associations between reactivity status and attrition in the Navy recruits (chi-square = 12.36, 4 df, $p < .015$) and in the Marine Corps recruits (chi-square = 32.88, 4 df, $p < .001$).

The loglinear model from one sample was cross-validated in the other sample by interchanging the cell-specific multiplicative model parameters, then determining the difference between the predicted and observed cell size based on this model. This difference was squared and divided by the expected cell size given the model to produce a cross-validated chi-square for the cell. The cross-validation chi-squares were summed across cells to compute an overall chi-square for the cross-validated model (cf., Table 1).

The efficiency of the cross-validated model was computed by comparing the cross-validated chi-square to the original chi-square for the attrition by typological status cross-tabulation. This original chi-square represents the difference between the observed and expected cell sizes if attrition and typological status were completely unrelated. This original chi-square model also represents the amount of improvement in fit of the model to the data provided by the loglinear model actually computed from the data. This second interpretation of the chi-square follows from the fact that the loglinear models fitted in each sample were saturated models which perfectly reproduce the cell sizes and, therefore, produce a resultant chi-square of zero.

Table 1
Stress Reactivity and Attrition

	R+	N	R-
Navy Sample			
Adaptive Attrition			
n =	9	17	4
lambda =	.213	-.241	.028
beta =	1.237	.786	1.029
lambda/SE(lambda)	1.02	-1.31	0.11
z =	1.9	-0.7	-0.5
Cross-val. z =	.02	1.07	.54
Other Attrition			
n =	17	54	5
lambda =	.177	.243	-.420
beta =	1.194	1.276	.657
lambda/SE(lambda)	.99	1.57	-1.75
z =	1.4	0.4	-2.2
Cross-val. z =	.36	1.65	.30
Graduates			
n =	220	963	257
lambda =	-.390	-.003	.392
beta =	.677	.997	1.480
lambda/SE(lambda)	-3.08	-.02	2.42
z =	-0.6	0.0	0.6
Cross-val. z =	1.38	1.19	2.10
Marine Corps Sample			
Adaptive Attrition			
n =	26	75	8
lambda =	.219	.021	-.240
beta =	1.244	1.021	.787
lambda/SE(lambda)	1.64	.19	-1.31
z =	2.7	-0.1	-2.2
Cross-val. z =	.02	2.27	.77
Other Attrition			
n =	32	88	9
lambda =	.264	.019	-.284
beta =	1.303	1.020	.753
lambda/SE(lambda)	2.09	.18	-1.61
z =	3.2	-0.2	-2.5
Cross-val. z =	.50	2.11	.41

Table 1
Stress Reactivity and Attrition
(continued)

	R+	N	R-
Marine Corps Sample			
Graduates			
n =	232	1269	309
lambda =	-.483	-.041	.524
beta =	.617	.960	1.688
lambda/SE(lambda)	-5.50	-.55	4.47
z =	-1.5	0.1	1.2
Cross-val. z =	1.41	1.34	2.31

NOTE: "R+" = Stress Reactive; "N" = Stress Neutral; "R-" = Stress Resistant. See analysis procedures for definitions of the reported statistics.

The cross-validated model did not fit the data well in the Navy sample (cross-validated chi-square = 12.15 versus null chi-square = 12.36), but did produce a substantial gain in the Marine Corps data (cross-validated chi-square = 19.71 versus null chi-square = 32.88). Stress resistant recruits showed no consistent tendency toward fewer adaptation problems (pooled $z = -0.66$, $p < .255$, one-tailed), but did evidence reliably lower attrition for other reasons (pooled $z = -1.95$, $p < .026$, one-tailed). Another noteworthy finding was that attrition status for the combined neutral groups was very close to the population average as indicated by the lack of any statistically reliable trends when the results for the two samples were combined (absolute pooled $z < 1.22$).

Additional Loglinear Models: Stress Reactivity With Dichotomous Attrition. Additional models were formulated on the basis of the replicable trends in the initial model. First, the loglinear parameters for graduation rate were more replicable than were the parameters for the specific types of attrition. This observation suggested that the attempt to distinguish between different types of attrition was unproductive. This possibility was tested by fitting a loglinear model which combined the two types of attrition into a single general attrition category. The chi-square for this model indicated significant associations between reactivity status and attrition in the Navy sample (chi-square = 10.90, 2 df, $p < .005$) and the Marine Corps sample (chi-square,

= 32.93, 2 df, $p < .001$). Of more importance, the cross-validation chi-squares were statistically nonsignificant in each case (Navy, cross-validation chi-square = 3.93; Marine Corps, cross-validation chi-square = 3.89). These cross-validation chi-squares accounted for 63.9% and 88.2%

Table 2
Stress Reactivity and Attrition for Dichotomous Attrition

	R+	N	R-
Navy Sample			
Attrites			
n =	26	71	9
lambda =	.298	.013	-.310
beta =	1.347	1.013	.733
lambda/SE(lambda)	3.25	.16	-2.59
z =	2.6	-0.2	-2.0
Cross-val. z =	.33	.99	.14
Graduates			
n =	220	1063	257
lambda =	-.298	-.013	.310
beta =	.742	.988	1.364
lambda/SE(lambda)	-3.25	-.16	2.59
z =	-0.7	0.1	0.5
Cross-val. z =	.58	.25	1.33
Marine Corps Sample			
Attrites			
n =	58	163	17
lambda =	.363	.030	-.394
beta =	1.438	1.031	.675
lambda/SE(lambda)	5.53	.55	-4.49
z =	4.2	-0.3	-3.4
Cross-val. z =	.49	.99	.21
Graduates			
n = 232	1269	309	
lambda =	-.363	-.030	.394
beta =	.695	.970	1.482
lambda/SE(lambda)	-5.53	-.55	4.49
z =	-1.5	0.1	1.2
Cross-val. z =	.64	.34	1.48

NOTE: "R+" = Stress Reactive; "N" = Stress Neutral; "R-" = Stress Resistant. See analysis procedures for definitions of the reported statistics.

of the null model chi-square. The improvement in fit provided by sample-based loglinear models was statistically nonsignificant compared to the cross-validated models for the Navy sample ($p > .140$) and the Marine Corps sample ($p > .143$). In addition, all of the individual model parameters were in the same direction in both samples, and those for stress reactives and stress resistant were consistently significantly different from zero (Table 2). The estimated parameters for R+ and R- were highly significant (absolute pooled $z > 4.55$, $p < .001$), while those for the N group were not significantly different from the population value (absolute pooled $z < 0.51$, $p < .695$).

Attrition and an Extended Reactivity Typology. A second extension of the initial loglinear model was based on the reliable tendency for the A- group to differ from the other two stress neutral groups noted in the neutral groups loglinear analysis. A loglinear model with four reactivity groups (R+, A-, combined A+ and C+, R-) and two attrition states (graduate, attrite) was fitted to the data. As would be expected from prior analyses, the resulting model indicated significant associations between attrition and reactivity status for both the Navy sample (chi-square = 13.57, 3 df, $p < .004$) and the Marine Corps sample (chi-square = 37.27, 3 df, $p < .001$). The cross-validation results were comparable to those obtained with the three-group reactivity typology (Navy cross-validation chi-square = 3.50, 3 df, $p > .320$; Marine Corps cross-validation chi-square = 3.91, 3 df, $p > .271$), so the cross-validated model accounted for 74.2% and 89.5% of the null model chi-square for the samples, respectively. As indicated in Table 3, all parameters in this model had the same sign in each sample, and the pooled zs were large enough to reject the null hypothesis (absolute $z = 2.28 - 5.74$) except for the N group (absolute $z < 1.34$).

Table 3

Relationship Between Extended Typology and Dichotomous Attrition

	R+	A-	N	R-
Navy Sample				
Attrites				
n =	26	30	41	9
lambda =	.283	.119	-.076	-.326
beta =	1.327	1.127	.927	.722
lambda/SE(lambda)	3.01	1.34	-.93	-2.44
z =	2.6	1.1	-1.1	-2.0
Cross-val. z =	.30	.03	.13	.27
Graduates				
n =	220	352	711	257
lambda =	-.283	-.119	.076	.326
beta =	.754	.888	1.079	1.385
lambda/SE(lambda)	-3.01	-1.34	.933	2.44
z =	-.7	-.3	.3	.5
Cross-val. z =	.89	.11	.61	1.42
Marine Corps Sample				
Attrites				
n =	58	65	98	17
lambda =	4.343	.125	-.054	-.414
beta =	1.409	1.133	.947	.661
lambda/SE(lambda)	5.14	1.98	-.96	-4.24
z =	4.2	1.5	-1.3	-3.4
Cross-val. z =	.46	.04	.21	.37
Graduates				
n =	232	402	867	309
lambda =	.343	-.125	.054	.414
beta =	.710	.882	1.055	1.513
lambda/SE(lambda)	-5.14	-1.98	.96	4.24
z =	-1.5	-.5	.5	1.2
Cross-val. z =	.92	.13	.65	1.54

NOTE: "R+" = Stress Reactive; "A-" = Low Agreeableness; "N" = Stress Neutral; "R-" = Stress Resistant. See analysis procedures for definitions of the reported statistics.

Dimensional Analyses

The dimensional analyses of personality and attrition began by determining the magnitude of attrition group differences in personality by one-way analysis of variance with attrition status as the group classification variable and personality dimension scores as the dependent variables.

These analyses indicated that neuroticism and conscientiousness were significantly related to attrition status in both samples (Table 4). Attrition status was significantly related to agreeableness in the Marine Corps sample ($p < .020$), and just failed to meet standard significance criteria in the Navy sample ($p < .051$). Extraversion was significantly related to attrition in the Navy sample ($p < .005$), but did not approach significance in the Marine Corps sample ($p < .733$). Openness to experience produced weak trends in both samples (Navy $p < .283$; Marine Corps $p < .152$). However, even the statistically significant associations involved modest effect sizes. Only in the case of neuroticism was attrition a strong enough correlate of personality to account for as much as 1% of the total variance in personality scores in both samples. The association between attrition and conscientiousness could account for more than 1% of the variance in conscientiousness in the Marine Corps sample (2.2%), but not the Navy sample (0.4%).

Table 4

Summary of Dimensional Associations to Attrition

	SS(3) (1)	F (2)	Sig (3)	SS(2) (4)	3-grp (5)	4-grp (6)	Exp (7)
Navy Sample							
Neuroticism	5.471	14.72	.000	3.609	.302	.356	.916
Extraversion	1.439	5.42	.005	.993	.365	.473	.632
Openness	.288	1.26	.283	.074	.152	.128	.---
Conscientiousness	1.834	3.31	.037	1.493	.020	.036	.987
Agreeableness	.925	2.98	.051	.614	.039	.066	.936
Marine Corps Sample							
Neuroticism	24.410	23.87	.000	23.653	2.687	2.649	.890
Extraversion	.297	.31	.733	.262	.192	.336	.267
Openness	.951	1.88	.152	.047	.037	.015	.213
Conscientiousness	13.404	23.90	.000	13.121	2.984	3.073	.777
Agreeableness	3.149	3.95	.020	3.0332	.241	.054	.923

NOTE: "SS(3)" is the sum of squares for personality differences between groups when attrition is treated as a three-group variable. "SS(2)" is the sum of squares for personality differences between groups when attrition is treated as a dichotomous variable. "3-grp" and "4-grp" refer to the sum of squares for personality differences between attrition groups with attrition treated as a dichotomous variable controlling for typological status in the original hypothesized three-group typology (R+/N/R-) and the four-group typology identified in the loglinear analyses (R+/A-/N/R-). "Exp" is the proportional reduction in variance from SS(2) (column 4) produced by controlling for the three-group typology. See text for details.

Dimensional Differences Between Attrition Groups. The next question was whether the distinction between the two attrition groups was useful. This question was posed in light of the evidence that the two types of attrition were comparably related to personality in the typology. In the Marine Corps sample, the variance in personality scores accounted for by attrition status was essentially the same whether two attrition categories were distinguished or whether attrition was treated as a single status (i.e., compare column 1 with column 4). In the Navy sample, the two-group contrast accounted for about two-thirds of the variance predictable in the three-group analysis.

Another approach to evaluating the importance of distinguishing between different types of attrition is provided by comparing the mean personality scores of the two attrition groups. In these comparisons, neuroticism was significantly higher among "other" attrites than "stress" attrites in the Navy sample ($t = 2.31$, p .022), but "other" attrites had lower scores in the Marine Corps sample ($t = -1.25$, $p < .212$). The only other difference which approached significance in either sample was lower openness among "other" attrites in the Marine Corps sample ($t = -1.80$, $p < .074$). Here again, the same comparison in the other sample showed a trend in the opposite direction with "other" attrites having slightly higher openness scores in the Navy sample (Navy sample $t = 0.72$, $p < .471$). As further confirmation that there were no reliable trends in the differences between the two attrition groups, the method of adding ts (Rosenthal, 1978) was used as a follow-up to the t-tests in the individual samples. This pooled t-test was employed to verify that any weak, but consistent, trends were not cumulatively statistically significant. All z-scores from these computations were less than 1.01 (absolute), so none of the cumulative tests passed standard significance criteria (range: $p = .157$ - .297).

Predictive Accuracy of Dimensional and Typological Models. Having demonstrated significant associations between dimensional personality scores and attrition and having shown that these associations were adequately summarized by treating attrition as a dichotomous variable, attention was directed to determining whether the dimensional model predicted attrition better than the typological model. To begin with, this question was addressed by examining the relationship between personality and attrition controlling for typological status. MANOVA with typological status and attrition as the group classification variables (cf., p. 15) was applied twice in each sample. Each application employed the dichotomous attrition variable as one grouping

factor. Attrition status variable was crossed with the three-group stress reactivity typology to test for the relationship between attrition and personality controlling for the theoretically correct model of stress reactivity. Dichotomous attrition status variable was crossed with a four-group typology which separated the "A-" group from the other neutral groups to test an empirically-derived four-group typology based on the loglinear analyses which suggested that this four-group typology might predict attrition better than the theoretically appropriate three-group typology.

Comparisons between the competing typological models suggested that the a priori three-group typology was preferable to the four-group typology. This inference was supported by the residual sums of squares relating personality to attrition controlling for typological status (see columns 5 and 6 of Table 4). In five of the seven cases where the bivariate association between the trichotomous attrition variable and personality were significant or nearly so ($p < .052$; cf., columns 2 and 3 of Table 4), the three-group typology produced smaller residuals than the four-group typology. The absolute magnitude of the differences was small in all cases, but given equivalent or slightly better reductions in group differences with the two models, the three-group model can be preferred either on the grounds that it generally tends to produce better fit to the data or that it involves fewer parameters (i.e., is more parsimonious) even if the differences in fit to the data provided by the dimensional model controlling for the alternative typological models is viewed as trivial.

Taking the three-group typology as the most suitable model, column 7 of Table 4 indicates the proportional reduction of covariation between personality and attrition provided by controlling for typological status. Some reduction in the covariance would be expected given that typological status and raw scores on personality necessarily are correlated. This necessity arises from the fact that the key reactivity types are defined by relatively extreme scores on the personality dimensions.

Typological status and scores on the personality dimensions are correlated because the dimensional scores are used to determine type. Controlling for typological status, therefore, may have reduced the covariation between attrition and scores on the personality dimensions only because of the correlation between typological status and personality scores. If so, it would be reasonable to expect the reduction in personality-attrition covariance resulting from controlling for typological status to equal the proportion of personality score variance explained by

typological status. For example, one-way analysis of variance with neuroticism as the dependent variable and three-group typological status as the group classification variable showed that typological status accounted for 40.0% of the variance in neuroticism in the U. S. Navy recruit sample. Controlling for membership status in the three-group typology accounted for 91.6% of the covariation between neuroticism and attrition (see Column 7 of Table 4). The observed reduction in covariance is 2.29 times as large as would be expected based on the association between neuroticism and the typology (i.e., 91.6/40.0). Similar computations for the other personality dimensions in the Navy and Marine Corps recruit samples produced the following:

Neuroticism: Navy = 2.29, Marine Corps = 1.83;

Extraversion: Navy = 2.98, Marine Corps = 1.35;

Conscientiousness: Navy = 1.73, Marine Corps = 2.87;

Agreeableness: Navy = 5.47, Marine Corps = 6.28.

Each of these ratios was greater than 1.00, and all of the personality dimensions which were related to attrition produced a ratio greater than 2.00 in at least one of the two recruit samples. This pattern indicates that controlling for typological status extracted more of the covariation between personality and attrition than would be expected based on the covariations between personality dimensions and typological status, particularly in the case of Agreeableness.

The final element of the dimensional analyses was a discriminant analysis with the five personality scales as the discriminating variables and the dichotomous attrition variable as the group classification to be predicted. The primary objective was to determine how well the optimal linear composite constructed from the personality scales in the discriminant function would predict attrition status. Given the weak bivariate associations between attrition and personality in these samples, precise prediction of attrition status was not expected, but determining the number of recruits who would have been predicted to attrite based on their personality scale scores was important.

Predictions based on discriminant functions are influenced by the prior probabilities of group membership employed in the analyses. In the present case, the probability of attrition initially was set equal to the observed rate of attrition. With this constraint, the discriminant function model predicted attrition correctly for one Marine Corps recruit. There were no false positives (i.e., recruits predicted to attrite who did not), so there was a net gain of one correct

prediction relative to the assumption that all recruits would graduate. In the Navy sample, all recruits were predicted to be graduates. A second set of analyses with prior probabilities set equal for attrition and graduation produced more correct predictions of attrition than the initial discriminant analysis (Marine Corps sample = 143; Navy sample = 87), but did so at the cost of a much larger increase in the number of graduating recruits who were incorrectly predicted to attrite (Marine Corps sample = 704; Navy sample = 1,082).

Even though neither discriminant analysis produced a model with high predictive accuracy, the predictions with prior probabilities set equal to the sample rates for graduation and attrition was more effective than the stress reactivity typology. The best prediction model for the typology is one which predicts that all recruits will graduate. This model applies because none of the different types of recruits has a graduation rate less than 50%. In this situation, the number of correct predictions based on the typology can be maximized by predicting that all recruits will graduate (cf., Hilderbrand, Laing, & Rosenthal, 1977). Thus, the dimensional model outperformed the typological model by one correct prediction in 4,748 cases when prior probabilities were equal to the observed graduation and attrition rates.

A Reactivity-Attrition Model Based on Combined Navy and Marine Corps Results

Having demonstrated that the two recruit populations had qualitatively and quantitatively similar relationships between reactivity status and attrition, the data from the two populations were combined. Loglinear analyses were conducted to analyze three-way crosstabulations defined by sample (Navy versus Marine Corps recruits), reactivity status, and attrition status. Based on the preceding analysis results, reactivity status was represented by the three-group stress reactivity model in one analysis and by the four-group typology in a second analysis.

One objective in these analyses was to obtain a second statistical test of the claim that the same loglinear model applied to both samples. If this claim were false, the relationship between reactivity and attrition would be different in the two samples. In these analyses, that difference would be reflected in the improvement in fit when the model changed from one based on two-way combinations of classification variables to one that included the three-way classification. The chi-square associated with this change in the models was clearly nonsignificant in both the analyses involving the three-group typology (chi-square = 0.56, 2 df, $p > .758$) and the four-group typology (chi-square = 0.66, 3 df, $p < .882$).

Table 5
Pooled Population Parameter Estimates

	Reactivity Model*			Extended Model*		
	Lambda	Beta	Ratio	Lambda	Beta	Ratio
Reactive (R+)	.335	1.398	6.29	.316	1.372	5.82
Low Agreeableness (A-)				.117	1.124	2.28
Neutral*	.035	1.036	.78	-.043	.958	-.93
Resistant (R-)	-.371	.690	-5.24	-.390	.677	-4.95

*"Reactivity Model" refers to groups defined on the basis of the hypothesized stress reactivity typology. In the three-group Reactivity Model, the Neutral group includes A- individuals. "Extended Model" refers to the modified typology which separates the hypothesized stress neutral group into those comprising the low agreeableness type and other stress neutral types. Parameter values in the table are given for the attrition group in the crosstabulation of type and attrition. The corresponding parameters for the graduating group are obtained by reversing the signs for lambda and the ratio of lambda to its standard error and by taking the inverse of beta (i.e., computing 1/beta).

The second objective in these analyses was to determine the pooled sample parameter estimates for the loglinear models. If the two samples are comparable, these parameter values provide the best empirical estimate of the parameters and should generalize more effectively to samples from other relevant populations. Table 5 shows the resulting parameter estimates for both the three-group and four-group typologies.

Application of the Models to Other Data

The models described in Table 5 were applied to the data reported by Vickers et al. (1991). The procedures were the same as those used in the cross-validation of models between the two general recruit populations. The fit of the four-group model to the data (chi-square = 14.82; .652 fit index) was better than that for the three-group model (chi-square = 18.11, fit index = .553). Both cross-validation models underestimated the attrition rate in the stress reactive group (three-group: chi-square = 4.10, 1 df, $p < .043$; four-group: chi-square = 5.60, 1 df, $p < .018$) and overestimated the graduation rate in their respective "neutral" groups (three-group: chi-square = 7.39, 1 df, $p < .007$; four-group: chi-square = 4.09, 1 df, $p < .044$).

Discussion

The present findings helped establish the generalizability of the initial Vickers et al. (1991) results in several ways. Stress reactivity status was related to attrition in both populations

studied, and the relationship in each sample was comparable qualitatively to that observed previously in recruits entering a medical rehabilitation program (Vickers et al., 1991). The stress reactivity typology provided a simple, useful summary of personality for predicting attrition in the general recruit populations from two different miliary services. When details of the research methods and findings are considered, the results also help establish that the observed associations generalize across populations with different attrition rates studied 10 years apart under different socioeconomic conditions and recruiting constraints, and using different personality inventories to determine reactivity status.

Comparison of Competing Typologies

While the general findings supported the utility of the stress reactivity typology for identifying military recruits at risk of attrition, a more complex typology might be even more useful. This conclusion was suggested by the reliable tendency for the A- group to have higher than average attrition. This trend was modest in each recruit sample, but the cumulative trend was highly significant.

The trends for the A- group might be explained in several ways that do not invalidate the stress reactivity typology. First, the possibility of classification errors must be considered because this group is near the R+ group in the five-factor personality space. Some R+ recruits may have been misclassified as A- because the two groups are relatively close together in the space defined by the personality dimensions. These misclassifications would inflate the estimated attrition rate in the A- group because of the higher than average attrition among the misclassified recruits. Second, A- individuals may be truly more likely to attrite from basic training than the average recruit, but not because they react poorly to training stress. Attrition is a complex process involving recruit behaviors, judgments by training personnel, and application of relevant administrative guidelines and policies. In this context, A- recruits may attrite more frequently than the average individual because their interpersonal style affects training personnel judgment calls or the probability of pre-enlistment behaviors which make the recruit ineligible for retention (e.g., not reporting a past record of delinquency as a result of suspicion about how the information will be used).

Simple coincidence provides a third possible explanation for the A- findings. This explanation is suggested by the fact that the A- personality profiles did not match very well

across samples (see Figure 1 and Appendix A). The imprecise match makes it uncertain whether, in fact, comparable groups have been defined in the two samples. The fact that the A- group experience an approximately average attrition rate in the Vickers et al. (1991) study provides additional reason to consider coincidence as an explanation because the trend did not replicate in the situation where the two A- groups could be regarded as closely matched.

The ambiguity of the A- findings suggests two constructive directions for additional work. Refinement of the classification procedures for the typology would help rule out the misclassification explanation. Direct investigation of how stress-related processes lead to attrition in the different groups would be needed to determine the relevance of different routes to attrition as an explanation.

Comparison to the Five-Factor Model of Personality

The findings also supported the three-group typology relative to the five-factor dimensional personality model. Controlling for typological status reduced the covariation between personality dimensions and attrition more than would be expected based on the strength of the observed associations between the scores on personality dimensions and group membership. One explanation for this finding might be that the typology was effective because group membership is really a composite variable integrating information about location on all five personality dimensions. However, the classification functions derived from the discriminant analyses also combine information from all five dimensions. In addition, the estimation of these functions involves the opportunity to capitalize on chance to maximize prediction. This opportunity arises because the discriminant function procedures combine personality data with knowledge of attrition status to produce post hoc sample-specific discriminant function weights that maximize the discrimination between attrites and graduates. The combined use of additional information (i.e., attrition status) and the estimation of sample-specific discriminant function weights provide significant opportunities for discriminant functions to outperform a predictive model which is specified a priori as the stress reactivity typology was in the present case. The fact that optimizing the relationships between personality and attrition produced an incremental prediction of only one individual in 3,648 recruits illustrates that the typological variable did virtually as well as this optimized alternative model. This finding is particularly encouraging when combined with previous results indicating that the typology outperformed the dimensional

model in the medical rehabilitation sample (Vickers et al., 1991).

The differences in overall attrition rates in the general recruit populations and the medical rehabilitation population may explain why the stress reactivity typology did better in the earlier study than in the present analyses. Additional studies of populations with relatively high attrition rates comparable to those in the medical rehabilitation study would be useful for exploring these issues further.

Stress Level Moderator Effects

The application of the loglinear models developed in the present studies to observations made in recruits undergoing medical rehabilitation suggests a hypothesis which could be tested in studies of high attrition populations. The extension showed that the predictive models from the general recruit population fit the medical rehabilitation data reasonably well as this reduced the chi-square more than 55% relative to the null model. The major areas of misfit between the general recruit model and the medical rehabilitation sample data were underestimation of attrition in the R+ group and overestimation of graduation in the N groups. The model fit the data for the R- group well. If the additional challenge of a moderately severe medical problem and the related higher attrition rate are accepted as indications of higher stress, these findings suggest that as stress increases the magnitude of differences between the stress reactivity groups increases. Additional research to test this hypothesized interaction between personality type and stress level would be a constructive extension of the present work.

Additional Issues

A distinction between attrition arising from poor behavioral adaptation to training stresses and other types of attrition was introduced to test the hypothesis that stress reactivity would be more strongly related to the former type of attrition. The data did not support this hypothesis. However, as noted in the discussion of the findings for the A- group, attrition from basic training is a complex process. In the context of this process, plausible arguments can be constructed that would predict more frequent attrition of R- recruits for reasons other than adaptational stress. For example, stress reactions might increase susceptibility to accidents or increase the probability that a previously unreported medical problem will be recalled during basic training in the hope of discharge. As another possibility, past reactions to stress may have resulted in behaviors that lead to attrition classified as "other" in the present study. These considerations lead to the

position that the attempt to discriminate between "stress relevant" and "stress irrelevant" attrition may have been misguided. If so, the lack of discrmination between adaptation discharges and other discharges probably should not weigh against any personality model, including the typological model.

The size of the bivariate associations between personality and attrition obtained in these samples is another issue to consider in the interpretation of the results. These relationships were small in absolute terms and relative to those typically reported in meta-analyses of personality-job turnover associations (Barrick & Mount, 1991; Kamp & Hough, 1988). As a result, the demonstration that continuous assessments of personality differences were weakly related to attrition status controlling for typological status was ambiguous. It is not clear whether this finding was obtained because the associations were so trivial that any adjustment would have worked or because the typology really provided a useful summary of personality-attrition relationships.

The overall attrition rates in the two populations may account for the weak bivariate associations. Extreme splits limit the potential correlation coefficients (Carroll, 1961; Wherry, 1984). With this caveat in mind, it may be more important that even the strongest associations were reduced to levels below those which would meet reasonable effect size criteria. The fact that the same general equivalence of the typology and dimensional analyses was obtained in the previous study by Vickers et al. (1991) suggests that the trends observed here will generalize to other settings where the attrition rate is higher. Additional research to confirm this trend in other populations with less extreme selection ratios would be desirable.

Summary and Conclusions

The combined results from the present study and Vickers et al. (1991) indicate that stress reactivity provides a typology which competes effectively with the best predictive model that can be developed for a dimensional model. The relative simplicity of the typological model gives it heuristic value for summarizing personality-attrition relationships. The fact that this model was specified independently of the attrition data and has independent theoretical and observational bases makes the typology more compelling as a scientific entity.

The present findings extended the evidence for a generalizable association between reactivity status and attrition. The same pattern of results occurred in two different recruit

populations undergoing basic training regimens that differed substantially in training emphases studied nearly 15 years apart and assessed with different measurement instruments. The construction of a single predictive model for the two populations underscores this point. At the same time, several elements of the findings point to potentially constructive extensions of the present work. Two areas which would be particularly useful in resolving ambiguities in the interpretation of the present findings would be the development of improved measures for typological status and investigation of the actual processes of responding to stress rather than merely examining an outcome variable such as attrition. The hypothesis that the typology is an increasingly potent predictor of attrition as the stress level/attrition rate in a population increases also merits attention. Additional work in these areas could improve the empirical basis for understanding and predicting basic training attrition.

References

Barrick, M.R., & Mount, M.K. (1991). The Big Five personality dimensions and job performance: A meta-analysis. Personnel Psychology, 44, 1-26.

BMDP Statistical Software, Inc. (1990). BMDP Statistical Software Manual Vols. 1 and 2. W. J. Dixon, M.B. Brown, L. Engelman, & R. I. Jennrich (eds). Berkeley, CA: University of California Press.

Bourne, P.G. (1967). Some observations on the psychosocial phenomena seen in basic training. Psychiatry, 30, 187-196.

Carroll, J. B. (1961). The nature of data or how to choose a correlation coefficient. Psychometrika, 26, 347-372.

Costa, P.T., Jr., & McCrae, R.R. (1985). The NEO Personality Inventory Manual. Odessa, FL: Psychological Assessment Resources.

Costa, P. T., Jr., & McCrae, R. R. (1992). The NEO PI-R Manual. Odessa, FL: Psychological Assessment Resources.

Costa, P. T., Jr., McCrae, R. R., & Dye, D. A. (1991). Facet scales for agreeableness and conscientiousness: A revision of the NEO Personality Inventory. Personality and Individual Differences, 12, 887-898.

Datel, W. E., & Engle, E. O. (1966). Affect levels in another platoon of basic trainees.

Psychological Reports, 19, 407-412.

Datel, W. E., Engle, E. O., & Barba, M. A. (1966). Affect levels in a company of basic trainees. Psychological Reports, 19, 903-909.

Datel, W. E., Gieseking, C. F., Engle, E. O., & Dougher, M. J. (1966). Affect levels in a platoon of basic trainees. Psychological Reports, 18, 271-285.

Datel, W. E., & Lifrak, S. T. (1969). Expectations, affect change and military performance in the Army recruit. Psychological Reports, 24, 855-879.

Hervig, L.K., Vickers, R.R., Jr., & Bischoff, C.W. (1991). Medical Rehabilitation Program. II. Effect on Attrition from Basic Training (Technical Report 91-29). San Diego: Naval Health Research Center.

Higley, J.D., & Suomi, S.J. (1989). Temperament reactivity in non-human primates. In G.A. Kohnstamm, J.E. Bates & M.K. Rothbart (eds.), Temperament in Childhood (pp. 153-167). NY: Wiley.

Hilderbrand, D. K., Laing, J. D., & Rosenthal, H. (1977). Prediction analysis of cross classifications. N.Y.: Wiley.

Janis, I.L. (1945). Psychodynamic aspects of adjustments to Army life. Psychiatry, 8, 159-176.

Joffee, P., & Naditch, M. P. (1977). Paper and pencil measures of coping and defense processes. In N. Haan (ed.), Coping and defending: Processes of self-environment organization. New York: Academic Press.

Kagan, J. (1989). Temperamental contributions to social behavior. American Psychologist, 44, 668-674.

Kagan, J., Reznick, J.S., & Snidman, N. (1986). Temperamental inhibition in early childhood. In R. Plomin & J. Dunn (eds.), The Study of Temperament: Changes, Continuities, and Challenges (pp. 53-67). Hillsdale, NJ: Erlbaum.

Kamp, J.D., & Hough, L.M. (1988). Utility of temperament for predicting job performance. In L.M. Hough (ed.), Literature Review: Utility of Temperament, Interest, and Biodata for Predicting Job Performance. Minneapolis, MN: Personnel Decisions Research Institute.

LaRocco, J. M., Ryman, D. H., & Biersner, R. J. (1977). Life history and mood as predictors of adjustment in Navy recruit training. Journal of Community Psychology, 5, 46-51.

Maskin, M.H., & Altman, L.L. (1943). Military psychodynamics: Psychological factors in the transition from civilian to soldier. Psychiatry, 6, 263-269.

Meehl, P. E. (1992). Factors and taxa, traits and types, differences in degree and differences in kind. Journal of Personality, 60, 117-174.

Milligan, G. W. (1981). A Monte Carlo study of thirty internal criterion measures for cluster analysis. Psychometrika, 46, 187-199.

Milligan, G. W., & Cooper, M. C. (1987). Methodology review: Clustering methods. Applied Psychological Measurement, 11, 329-354.

Overall, J.E., & Magee, K. N. (1992). Replication as a rule for determining the number of factors in hierarchical cluster analysis. Applied Psychological Measurement, 16, 119-128.

Rose, R.M., Poe, R. O., & Mason, J. W. (1968). Psychological states and body size as determinants of 17-OHS excretion. Archives of Internal Medicine, 121, 406-413.

Rosenthal, R. (1978). Combining results of independent studies. Psychological Bulletin, 85, 185-193.

Rosenthal, R., & Rosnow, R. L. (1984). Essentials of behavioral research. N.Y.: McGraw-Hill.

Sapolsky, R.M. (1990a). Adrenocortical function, social rank, and personality among wild baboons. Biological Psychiatry, 28, 862-878.

Sapolsky, R.M. (1990b). Stress in the wild. Scientific American, 262, 116-123.

SPSS, Inc. (1988). SPSS-X User's Guide (3rd Edition). Chicago: SPSS, Inc.

Tellegen, A. (1991). Personality traits: Issues of definition, evidence and assessment. In D. Cicchetti & W. Grove (Eds.), Thinking clearly about psychology: Essays in honor of Paul Everett Meehl (pp. 10-35). Minneapolis: University of Minnesota Press.

Vickers, R.R., Jr. (1991). Stress reactivity: Five-factor representation of a psychobiological typology (Technical Report 91-26). San Diego: Naval Health Research Center.

Vickers, R. R., Jr., & Conway, T. L. (1983). The Marine Corps basic training experience: Psychosocial predictors of performance, health, and attrition (Technical Report 83-7). San Diego: Naval Health Research Center.

Vickers, R. R., Jr., Hervig, L. K., & Bischoff, C. W. (1991). Stress reactivity: Prediction of attrition following medical problems in basic training (Technical Report 91-48). San Diego: Naval Health Research Center.

Vickers, R. R., Jr., Hervig, L. K., Wallick, M. T., Poland, R. E. & Rubin, R. T. (1987). Psychological correlates of cortisol secretion in normal individuals under stress (Technical

Report 87-1). San Diego: Naval Health Research Center.

Ward, J. H. (1963). Hierarchical grouping to optimize an objective function. Journal of the American Statistical Association, 58, 236-244.

Wherry, R. J., Sr. (1984). Contributions to correlational analysis. San Diego, CA: Academic Press.

Zurcher, L.A., Jr. (1968). The naval recruit training center: A study of role assimilation in a total institution. Sociological Inquiry, 31, 85-98.

Appendix A
Development of a Provisional Stress Reactivity Typology for Marine Corps Recruits

Background

The specific procedures utilized to develop a provisional typology for the Marine Corps recruits were those employed by Vickers (1991). The rationale for the procedures was presented in that earlier report, so the present description will be limited to a general overview of the procedures and presentation of the results.

Procedures

The typology development employed cross-sample replication as a criterion for determining the appropriate number of clusters to represent the sample. Cluster replication was determined by dividing the sample randomly into five subsamples. Hierarchical agglomerative clustering was applied within each subsample and cluster memberships for each recruit were saved for the solutions involving two through six clusters.

The second phase of the analysis focused on replication of different clusters across subsamples. This phase began by determining the average personality profile for each of the 20 clusters defined in the first phase of the analysis. These profiles then were treated as "cases" in a second cluster analysis procedure undertaken to determine which clusters matched across subsamples. This procedure was performed five times, once with the 30 profiles resulting from the six-cluster solutions in the five subsamples, once with the 25 profiles resulting from the five-cluster solution in the five subsamples, and so on for the four-, three-, and two-cluster solutions. An ideal replication of clusters across subsamples occurred if each subsample had exactly one of its clusters assigned to the clusters in this secondary analysis.

The third phase of the analysis returned to the problem of classifying individuals. For each subsample, a criterion for assigning participants to clusters was developed by taking the average of the classification functions for the other four subsamples. Each individual's classification based on this external criterion was compared to his classification based on the cluster analysis in his subsample. Like the preceding analyses, this procedure was repeated for each cluster solution separately. The convergence of the sample-specific classification and the external classification was summarized in terms of kappa, the Rand statistic, and the adjusted Rand

statistic, three common measures of convergence between different cluster solutions (Milligan & Cooper, 1987).

The sequence of procedures then was repeated using Ward's (1963) clustering method with the cluster personality profiles from the preceding analyses as the starting profile for assignment. This additional procedure was used because Ward's procedure is the most effective means of recovering known cluster membership in simulation studies provided reasonable estimates of the true cluster centroids are available. As will be seen below, this procedure slightly increased the measures of assignment accuracy.

Results

The initial hierarchical analysis indicated that as many as six clusters might be needed to extract the reliably defined groups from the data (Table A-1). A two-group solution was ruled out by the fact that the Rand and Adjusted Rand statistics were no greater than would be expected by chance. Both of these statistics reached their maximum value for the six-group solution, while the three-group solution was the maximum for kappa.

The application of Ward's clustering algorithm changed the picture regarding the optimum level of clustering. In this evaluation, the two-group solution was excluded from consideration on the basis of the initial findings and evidence that two-group solutions can excessively capitalize on chance (Overall & Magee, 1992). With this exclusion, all three statistical criteria reached a maximum value for the five-group solution.

Table A-1
Summary of Cluster Analysis Results for Marine Corps Recruit Sample

	2-Group	3-Group	4-Group	5-Group	6-Group
Hierarchical Analysis					
Kappa					
Mean	.435	.400	.385	.346	.299
Standard Error	.032	.044	.030	.034	.031
Rand					
Mean	.562	.616	.687	.742	.795
Standard Error	.024	.007	.008	.008	.007
t-test**	-.333	6.571	14.625	21.500	32.143
Significance	.374	.000	.000	.000	.000
Adjusted Rand					
Mean	.118	.209	.254	.277	.347
Standard Error	.048	.014	.017	.021	.025
t-test***	.375	7.786	9.059	8.429	9.880
Significance	.359	.000	.000	.000	.000
Partitioning Analysis					
Kappa					
Mean for Subsamples	.529	.463	.438	.465	.370
Standard Error	.046	.040	.024	.032	.046
Rand					
Mean for Subsamples	.603	.655	.694	.760	.788
Standard Error	.031	.011	.011	.010	.008
t-test**	1.065	7.727	11.273	19.000	27.250
Significance	.161	.000	.000	.000	.000
Adjusted Rand					
Mean for Subsamples	.205	.263	.250	.301	.279
Standard Error	.031	.024	.022	.023	.022
t-test***	3.387	6.792	6.818	8.739	8.136
Significance	.006	.000	.000	.000	.000

* Chi-square/degrees-of-freedom ratio for test of consistency of proportions for cluster membership across subsamples.

**t-test (9 df) for the null hypothesis that Rand = .57 based on Milligan's (1981) findings for random data.

***t-test (9 df) for the null hypothesis that Rand = .10 on Milligan's (1981) findings for random data.

Quantitative Comparison of Group Profiles Across Samples

An additional step was taken to evaluate how well the group profiles derived in these analyses compared to the profiles obtained in the earlier work with Navy recruits (Vickers, 1991). To begin with, the Marine Corps group profiles were transformed to approximate the Navy group profiles by adding and multiplying by the appropriate constants to adjust for differences in the sample means and standard deviations. The profiles expressed in terms of these scores then were used to compare the profiles across samples.

The comparisons were made by computing the sum of the Euclidean distances between the profiles of individuals within a group and a number of comparison profiles. Two comparisons to sample-based profiles were made. One of these comparisons used the sample mean profile as the reference vector. The second sample-specific profile was the average personality vector for the individual's cluster based on his assignment in the present cluster analyses. The difference between the sum of the Euclidean distances for these two reference vectors is equal to the reduction in variance provided by substituting the group mean for the sample mean. This variance provided a frame-of-reference value for evaluating the effects of matching the group profile to profiles derived from the Navy recruits.

The comparisons to the Navy recruit profiles proceeded by computing the Euclidean distance between each participants personality profile and each of the Navy recruit profiles under consideration (e.g., all three, four, or five depending on the number of groups under consideration). These variances were transformed into matching indices by computing the following ratio:

Matching Index = (Navy Sum - Sample Average)/(Sample Sum - Sample Average)

Groups were matched across populations by first matching the two groups with the largest matching index, then matching the two groups in the remaining subsets with the largest matching index, and so on.

The results were comparable for the three-, four-, and five-group typologies. Two groups were identified with substantial matching indices; one group had a small positive matching index, and the remaining groups had negative matching indices. In the three-group analyses, the two

groups with the large matching indices were R- (.674) and the intermediate group (.580), while the R+ group had a small matching index (.060). In the four-group analyses, the large matching indices were the R- (.747) group and a group with a high score on conscientiousness (.732), with the R+ index small, but positive (.038), and the remaining index in the negative range. In the five-group analyses, the matching index was highest for R+ (.896), followed by R- (.759), and C+ (.336). The remaining matching indices were slightly negative.

Conclusions

The findings in these analyses reinforced the initial decision to define the provisional typology in terms of a five-group solution. The same number of groups was identified as the most replicable solution in the present analyses and the group profiles were sufficiently similar to those in the previous study (cf., Figure 1) to assume typological matching with some confidence. The matching indices described above indicated that at this level of analysis, the R+, R-, and C+ groups could be identified with some confidence, but the matching of the A+ and A- groups was equivocal. However, this level of matching was superior to that obtained in the prior analyses which failed to identify the R+ group in the four-group analyses and showed less convergence of the R+ and R- profiles across samples in the three-group analyses. Taken in the context of a typological model which assumes that there are three types, R+, R-, and N, the five-group solution did the best job of identifying replicable instances of the theoretically critical groups while still providing at least one competing group that replicated reasonably well and could invalidate the model if it were related to important criteria.

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Previous observations linking stress reactivity to attrition in military recruits who experienced medical problems during basic training were extended to the general recruit populations using data from male volunteer U.S. Navy recruits (n = 1,546) and U.S. Marine Corps recruits (n = 2,079) who completed measures of the five-factor personality model. The personality measures were used to classify recruits as stress reactive (R+), stress neutral (N), or stress resistant (R-). Attrition from basic training was related to stress reactivity status with R+ recruits having above average attrition and R- recruits having below average attrition in both populations. Comparison to a dimensional treatment of personality indicated that the stress reactivity typology extracted the useful variance from the personality measures as well as a discriminant function derived from these measures with attrition as the criterion variable. Comparison to more complex typological models suggested that a four-group typology might be preferable to the hypothesized three-group typology. Refined methods of measuring stress reactivity and tests of hypotheses regarding the processes by which reactivity affects attrition are needed to address this possibility and extend the comparison of the reactivity typology to dimensional personality models.

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